Type I Progress Report

Period ended March 31, 1973

a - Title - ERTS Data User #119 - Effective Use of ERTS Multisensor Data in the Great Plains

b - Principal Investigator number - Victor I. Myers UN-642

c - Problems impeding progress - none

d - Accomplishments

1. Rangeland (Dr. Lewis, Investigator)

   (a) During August and early September, 1972, vertical 35 mm Ektachrome stereograms of ¼m² plots were taken to provide ground truth within mapping units delineated on enlargements (4" = 1 mile) of Ektachrome infrared 70 mm Hasselblad imagery taken from 10,000 ft. AGL along 4 flight lines in western South Dakota. A subsample of these plots was clipped with electric shears and the mulch cover was vacuumed. Fresh and oven dry weights of total herbage and of herbage components and oven dry ash free weights of mulch have been determined in the laboratory.

   (b) During this reporting period the groups of these 35 mm Ektachrome photos of known plant material were digitized and an output map produced using the K-class classifier and a mode-seeking program with data from only one vegetation group or from three vegetation groups. Data are presented in a Master's thesis by G. K. Kaveriappa, Electrical Engineering Dept., SDSU, Brookings, South Dakota.

2. Cropland (Dr. Horton, Investigator)

   (a) Each of the four August transparencies for the Centerville study area was digitized at a resolution of 36 data points per mm using Signal Analysis and Dissemination Equipment (SADE). The coded outputs proportional to optical transmission for each band were printed out in a spatial format which divided the 0 to 255 range of coded outputs into 51 increments of five values each. A specific character was assigned to each increment.

(b) Three corn fields, two soybean fields, and two fallow fields representative of the three classes in the study area were chosen as training fields and were located on the printouts. An 8 point by 8 point matrix inside each field boundary was used as the statistical sample of data points for the field. Data were obtained using a computer program with inputs being the initial x and y coordinates of each matrix along with the size of the matrix. The coordinates were measured only on the band 6 printout under the assumption that errors in the masking operation would not be great enough to cause misregistration in bands 4, 5 and 7. K-class classification (Zagalsky, 1968) was performed on the three classes of data.

(c) The data for band 6 was further analyzed using an automatic mode seeking program (Sebestyen, 1966 and RSI memo dated Dec. 13, 1972 to V. I. Myers from G. K. Kaveriappa on the subject of mode seeking). The present form of the mode seeking program was developed by G. K. Kaveriappa, a graduate student in electrical engineering at South Dakota State University. The mode seeking program is now part of the software system in SADE.

3. Land Systems (Dr. Westin, Investigator)

(a) Selected parts of all four bands of ERTS scene 1025-16551, 17 August 1972, were enlarged to approximately 1:285,000 scale. These enlargements were examined for evidence of erosion along the Missouri River.

4. Data Analysis

See comments under paragraphs 1 and 2 above.

e. Significant Results

1. Rangeland (Dr. Lewis, Investigator)

(a) Manipulation of the digitized material from the photos mentioned in paragraph d1 (b), revealed that the mode-seeking program using only one vegetation group gave the best output map. However, consistent misclassification resulted from failure to separate images with similar transmission values in somewhat different wave lengths. Efficient mapping of this imagery will possibly require the use of narrow band filters.

(b) During the coming weeks, the ratios of different bands of multispectral aircraft imagery and of ERTS imagery will be studied in relation to ground truth along the four flight lines. In addition, photo-interpretation techniques will be used to examine variations attributable to range vegetation within the soil association delineations developed by Dr. Fred C. Westin. Ground truth in areas away from the four flight lines will be provided by recent range vegetation maps compiled by various federal agencies in western South Dakota.

2 - Cropland (Dr. Horton - Investigator)

(a) Results obtained with the K-class classifier are shown in Table 1. Using one feature, the highest percent correct classification was obtained using band 6. Using two features, best results were obtained using bands 4 and 6 and bands 5 and 6. Using three features, good results were obtained using bands 4, 5, and 6; bands 4, 6, and 7; and bands 5, 6, and 7. Results obtained using all four features were also satisfactory.

TABLE 1. Percent total correct classification of the training samples

Feature in terms of ERTS bands	Percent total correct classification
4	46.65
5	47.10
6	87.28
7	42.86
45	61.38
46	83.04
47	46.65
56	93.75
57	45.10
67	90.40
456	81.92
457	63.84
467	82.59
567	93.53
4567	81.47

(b) Figures 1, 2, 3, and 4 show the probability density functions of each class in bands 4, 5, 6, and 7 respectively. The peaks and valleys in the curves are due to the small number of data points that were sampled. It is assumed that a larger sample of data points would result in smoother curves.

(c) Little separation of classes was achieved in band 4 except for one corn field represented by the curve in the left hand portion of figure 1. The difference between this corn field and the other corn fields does not appear to be related to soil differences. No explanation of the differences between the corn fields has been found. The sharp fallow peaks indicate that some discrimination of bare soil was achieved. Also, some separation of soybeans was achieved.

(d) Figure 2 shows some separability of corn for lower class output values. It also shows significant overlap of the three classes. Some discrimination of fallow and little discrimination of soybeans was obtained in band 5.

(e) Figure 3 shows that almost complete separation of classes was obtained in band 6. The excellent separation of classes achieved in band 6 is reflected in K-class classifier results where this band in included.

(f) A visual analysis of the band 7 printout indicated that discrimination of the three classes was possible in band 7. This does not completely agree with figure 4. The reason for the discrepancy lies in the masking operation on the band 7 transparency. When the matrix coordinates based on band 6 measurements were fed into the computer, the masking error caused some of the data points in band 7 to be samples outside the field boundaries.

(g) The mode seeking analysis of band 6 data verified the results shown in figure 3. The significance of this is that the computer when instructed to seek three modes under the assumption that the data was unimodal gave the same results as human analysis of the data in the form of probability density functions. Only two of the 448 data points were misclassified. Further analysis of the data using mode seeking was conducted under the assumption that the data for each class was bimodal. Using the mode-seeking algorithm, only five of 448 total data points were misclassified. The above results indicate that mode seeking will be a useful tool for automatic crop discrimination.

(h) During the next reporting period, the entire 2 mile by 9 mile study area will be classified using K-class and the seven training fields mentioned earlier in this report. Further use of mode seeking is also anticipated. It is hoped that mode seeking can be used in conjunction with K-class to improve classification accuracy. It is also anticipated that digital analysis of September 2 imagery will begin during the next reporting period.

3 - Land Systems (Dr. Westin - Investigator)

(a) The eroded shale soils located along the Missouri River reservoirs in South Dakota above the Fort Randall and Big Bend Dams are clearly visible on the IR bands of ERTS scene 17 August 1972, image description number 1025-16551. These thin shale soils are barren of vegetation due to very low soil fertility, a dense consistence, and steep slopes. Although barren, they are dark-olive to black in color because that is the color of the shales of this area. Thus, these eroded areas are dark and have low reflectance in the 7 band causing them to stand out sharply from the higher reflectance of the adjacent grass-covered areas above and below them in the landscape. The reflectance differential of these eroded areas from the adjacent areas is less on the 6 band but it is enough so that the eroded areas stand out. On the 5 and 4 bands the reflectance differential of the eroded and adjacent areas is about the same so that the eroded areas are not visible on these two bands. See examples in figures 5 and 6.

(b) The presence of barren soils just above these reservoirs is serious because of their potential to contribute sediment to the reservoir. It appears that MSS band 7 of ERTS would be useful to estimate rates at which sediment is being added to these reservoirs and to monitor attempts to control the erosion.

(c) Caution should be exercised in evaluating eroded areas on ERTS imagery, however, since the color of the sediments influences the amount of reflectance recorded. Therefore, an eroded area may appear dark or light, depending upon the type of sediment present. See figures 7, 8, and 9 as examples.

f - Published Articles

1. Identification of Soil Associations in Western South Dakota on ERTS-1 Imagery. Dr. Fred Westin and Victor I. Myers. Paper presented at ERTS Symposium in March 1973 and published in proceedings. Dr. Westin has been invited to present this paper at the Committee on Space Reach (COSPAR) Seminar to be held in Konstanz, Germany on May 23-25, 1973.

2. Crop Identification Using ERTS Imagery. Maurice L. Horton and James L. Heilman. Paper presented at ERTS Symposium in March 1973 and published in proceedings.

g - Recommendations - none

h - Changes in Standing Order Forms - The original standing order form requested all ERTS imagery with 50% or less cloud cover. The cloud cover limitation has now been omitted in the standing order request and all imagery has been requested regardless of amount of cloud cover.

i - Image Description Forms - none

j - Data Request Forms - Back order forms to request imagery that had previously been missed due to the cloud cover limitation have been submitted and are attached as enclosures 1 and 2.

k - Other Information - no change

References

Sebestyen, G. An algorithm for nonparametric pattern recognition. IEEE Transactions on Electronic Computers, Vol. EC-15, No. 6, Dec. 1966, pages 908-915.

Zagalsky, N. 1968. A new formulation of a classification procedure. M.S. Thesis, University of Minnesota, St. Paul, Minnesota.

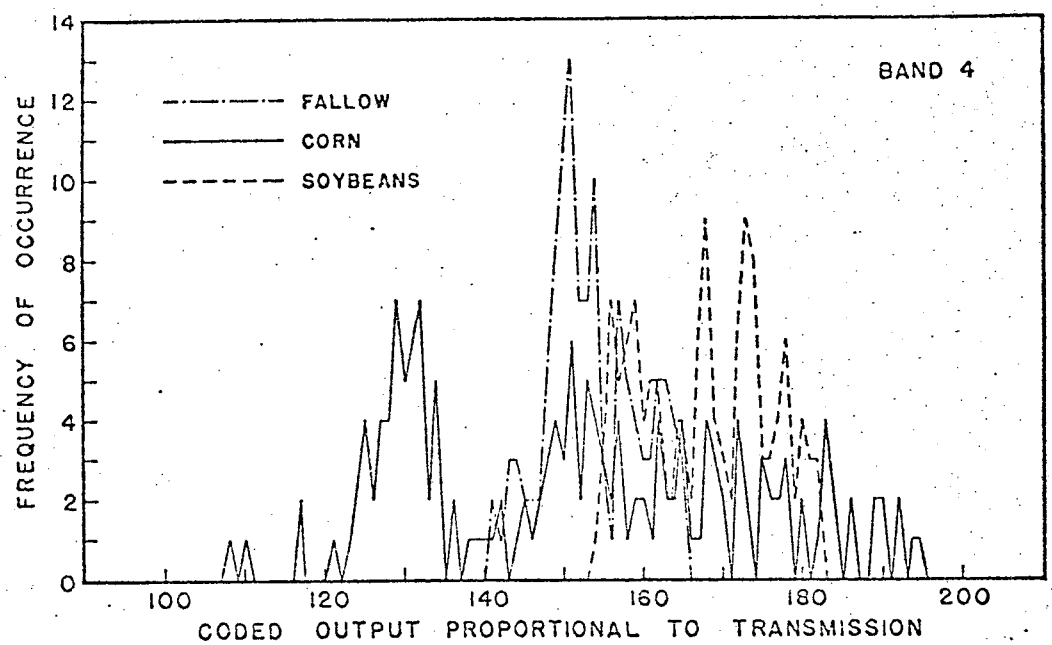

Figure 1. Probability density functions of corn, soybeans, and fallow in band 4 (0.5-0.6 μm)

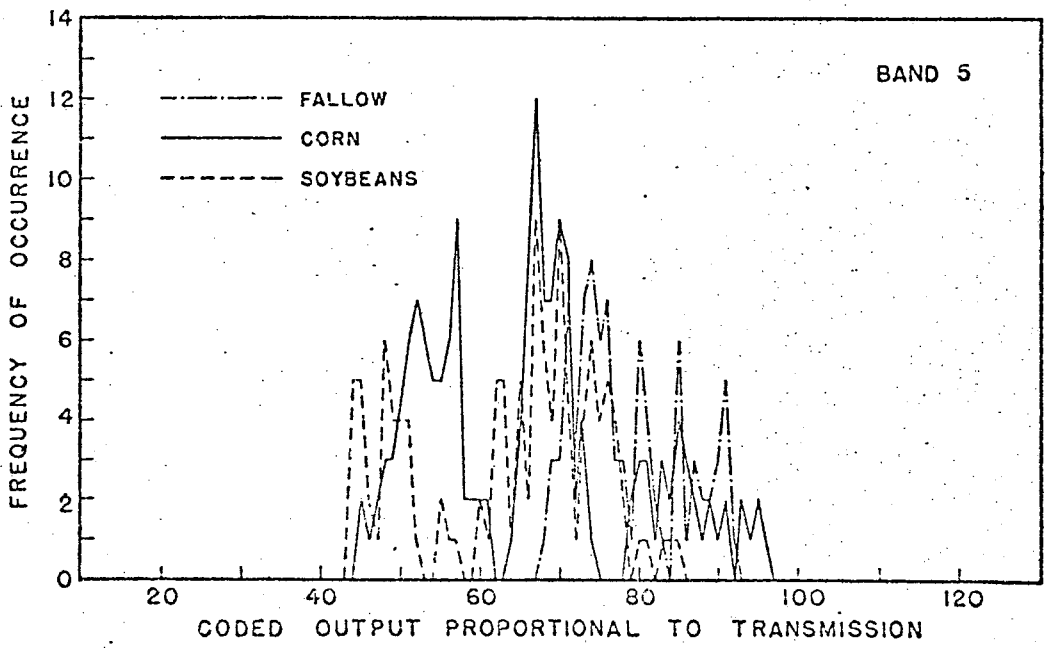

Figure 2. Probability density functions of corn, soybeans, and fallow in band 5 (0.6-0.7 μm)

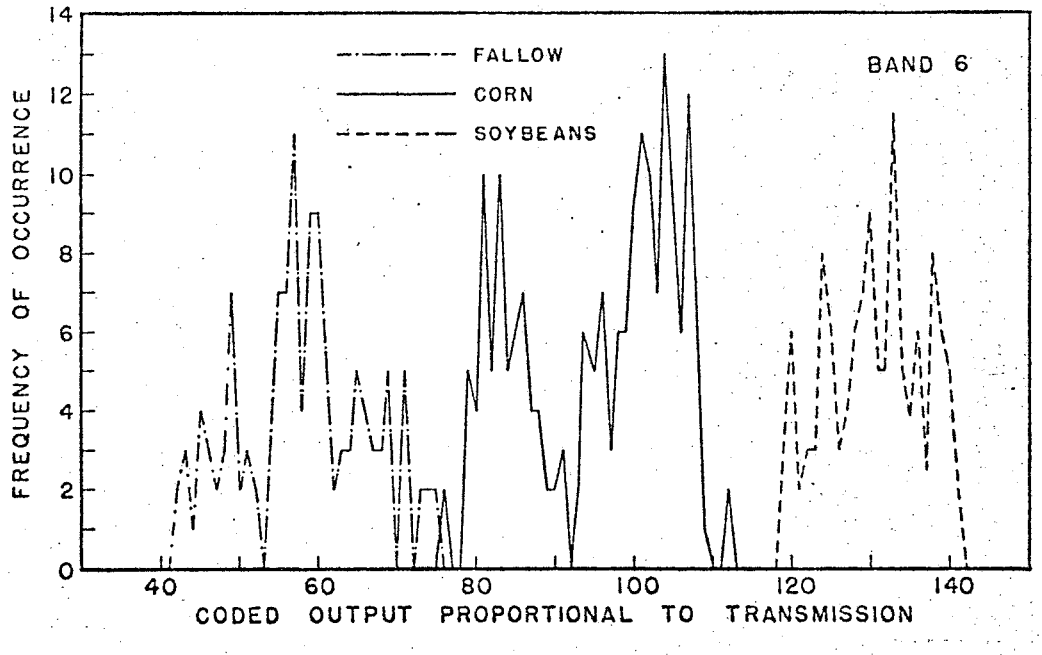

Figure 3. Probability density functions of corn, soybeans, and fallow in band 6 (0.7-0.8 μm)

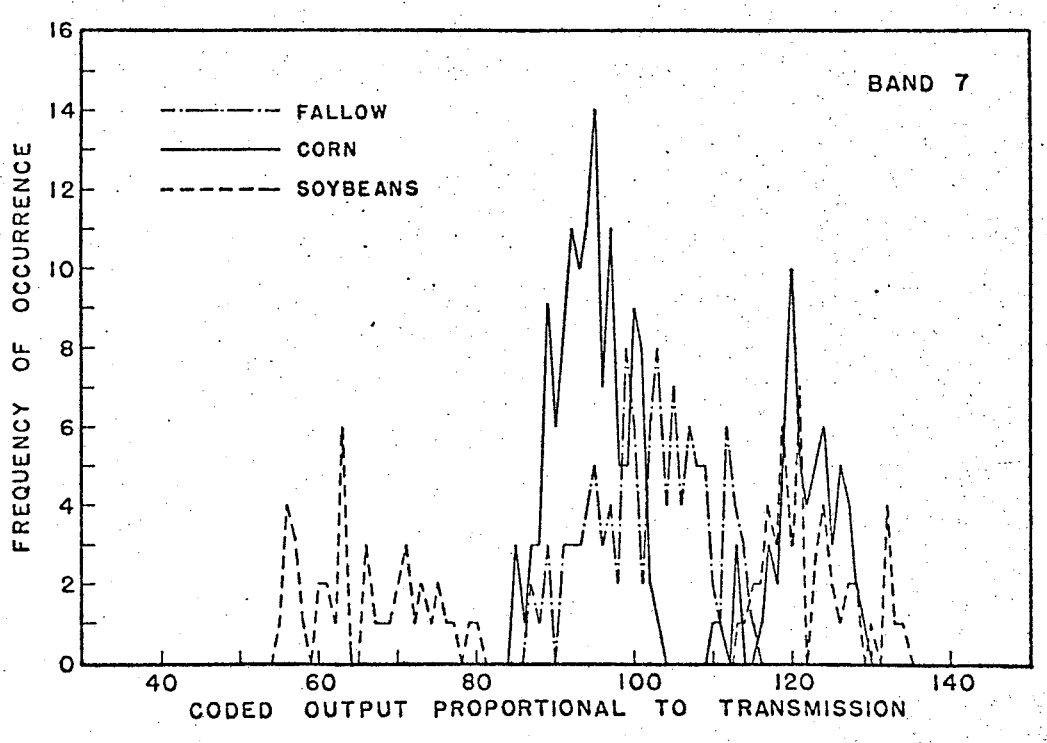

Figure 4. Probability density functions of corn, soybeans, and fallow in band 7 (0.8-1.1 μm)

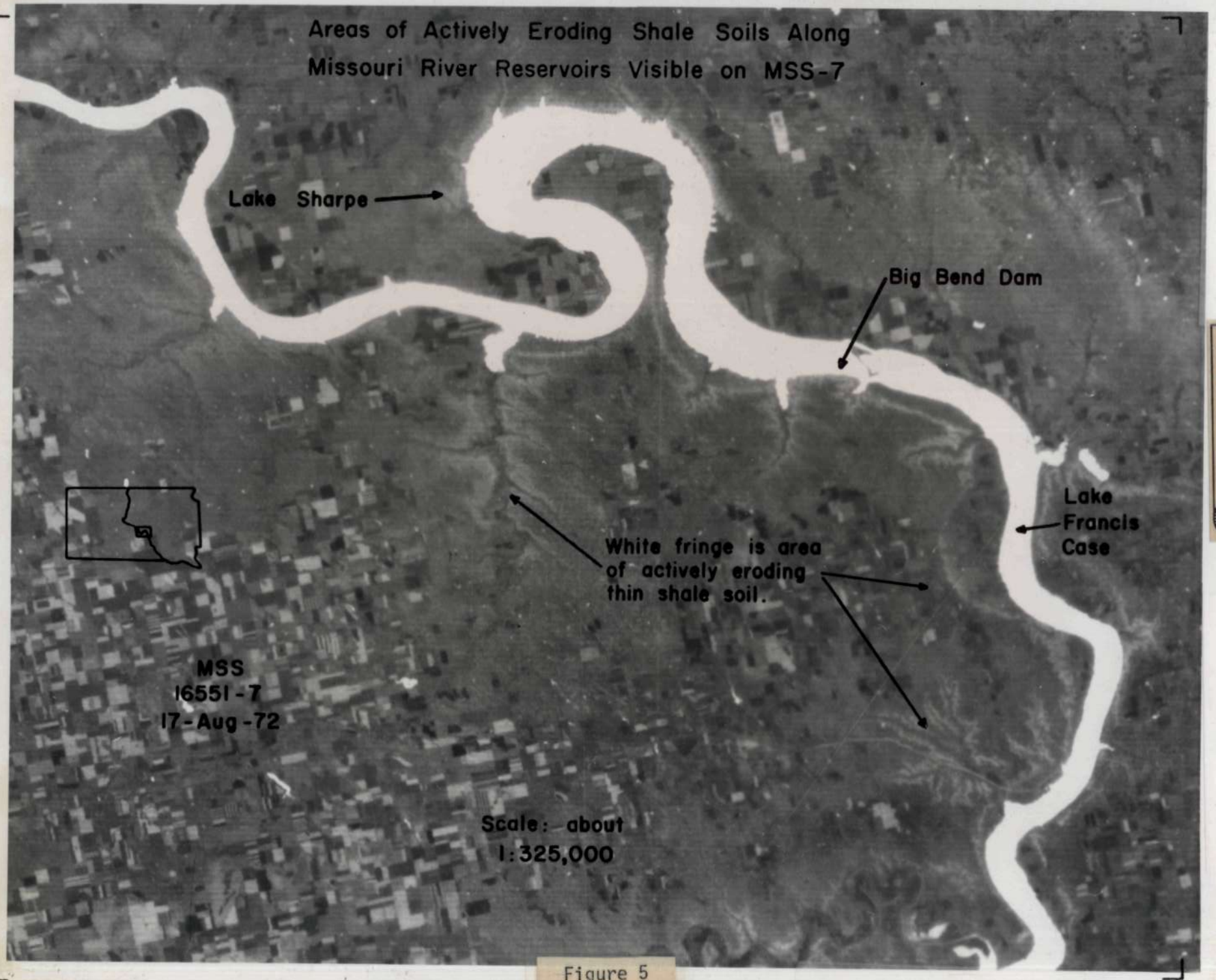

Figure 5

ERODING SHALE SOIL S ADJACENT TO MISSOURI RIVER RESERVOIR ON 4 MSS BANDS

SCALE ABOUT 1:285,000

MSS-4

N

MSS-6

MSS-5

MSS-7

The white "fringe" area, which is most visible on MSS-7, less visible on MSS-6, and not apparent on MSS-4 or MSS-5 is the eroded shale soil

Figure 6

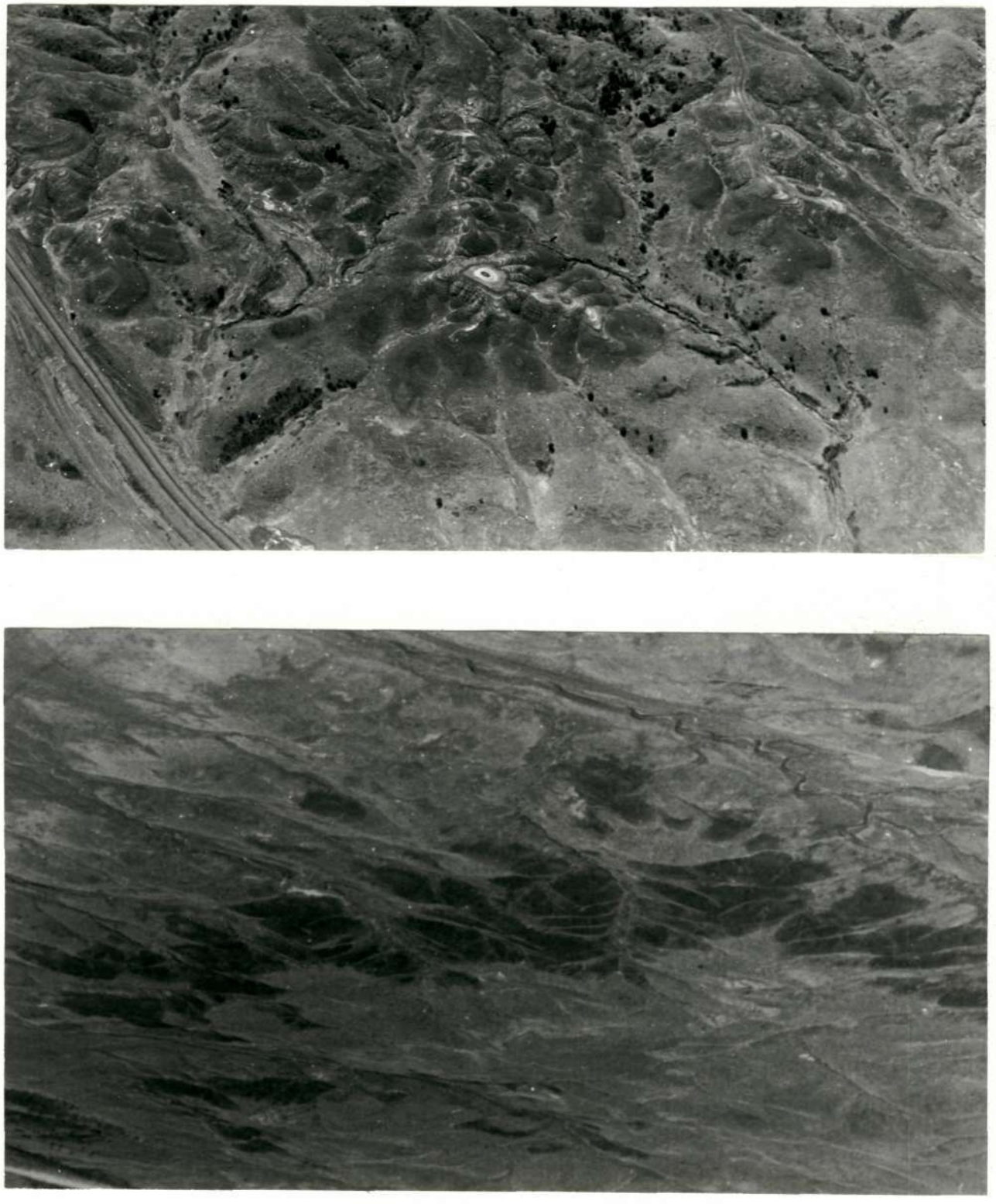

Figure 7 - Oblique photographs showing dark areas of eroding shale soils along the Missouri River.

Differentiating erosion of light colored versus
dark colored sediments on MSS-7 of ERTS 1 images

Badlands - Western S. D.
MSS-7 19 Aug 72 17065

Missouri River Reservoir, Central S. D.
MSS-7 17 Aug 72 16551

The Badlands soil materials are light-colored, and, where the tone of the image is darkest on this negative print, they are barren of vegetation. On band 7 they have a higher reflectance than the adjacent grasslands and so appear darker than the adjacent areas. Along the Missouri River reservoir the eroding shale soils are black and have a lower reflectance on the 7 band than the adjacent grasslands, thus they appear as a light colored fringe above the reservoir. Negative prints.

Figure 8

Figure 9 - Oblique photograph of Badlands in Western South Dakota. Light colored sediments show as dark areas on the negative prints of MSS band 7 of ERTS imagery. For comparison of appearance of dark and light colored sediments on ERTS imagery, see figure 8.

Enclosure 1

15

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Enclosure 2

19

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